

Artificial Intelligence and Digital Transformation in the National Environmental Standards and Regulations Enforcement Agency, 2014-2026

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Abstract

Artificial Intelligence (AI) and digital transformation have increasingly become important instruments for improving efficiency, transparency, accountability, decision-making, and service delivery in public organisations. This study examined Artificial Intelligence and digital transformation in the National Environmental Standards and Regulations Enforcement Agency (NESREA) from 2014 to 2026. Specifically, the study sought to examine the influence of machine learning on bureaucratic imperatives and the influence of digital data management systems on decision-making. The study adopted the survey research design and used primary and secondary data. The population of the study comprises 300 officials from which 171 respondents were determined using Taro Yamane's formula and purposively selected. Structured questionnaire were administered to elicit information from the 160 retrieved questionnaire which was subsequently analysed, representing a 93.6% retrieval rate. The research instrument was validated by experts, while reliability was determined using Cronbach's Alpha. Data were analysed using descriptive statistics and Pearson Product-Moment Correlation in SPSS. Findings showed that machine learning improved on administrative imperatives, with a grand mean of 2.98 and a positive relationship with bureaucratic efficiency at; $r = 0.684$, $p = 0.000$. Digital data management systems enhanced decision-making at; grand mean = 3.04; $r = 0.721$, $p = 0.000$. The study concluded that digital technologies significantly strengthened administrative performance in NESREA. The study thus, recommended that NESREA should adopt stronger machine learning, and improved digital data infrastructure, as well as staff capacity development, and technical support in order to improve and sustain NESREA environmental governance capacity.

Keywords: Artificial Intelligence, Digital Transformation, Machine Learning, E-Governance, Environmental Governance.

Introduction

The emergence of Artificial Intelligence (AI) as a transformative technological innovation has significantly altered the dynamics of governance and public administration across the world. In the 21st century, governments are increasingly leveraging AI and other digital technologies to improve efficiency, transparency, accountability, and service delivery. This shift is part of a broader phenomenon known as digital transformation, which involves the integration of digital technologies into all aspects of public sector operations. Digital transformation goes beyond mere automation; it entails a fundamental reconfiguration of

administrative processes, institutional frameworks, and governance structures (Mergel, Edelmann, & Haug, 2019). In developing countries such as Nigeria, the adoption of AI and digital transformation is particularly critical due to persistent challenges associated with bureaucratic inefficiencies, corruption, weak institutional capacity, and poor service delivery. Artificial Intelligence refers to the simulation of human intelligence processes by machines, especially computer systems. These processes include learning, reasoning, problem-solving, perception, and decision-making. AI technologies such as machine learning, natural language processing, and predictive analytics have proven to be highly effective in enhancing governance processes by enabling data-driven decision-making and automating repetitive administrative tasks (Russell & Norvig, 2021). In the context of public administration, AI can be utilized to improve policy formulation, optimize resource allocation, enhance regulatory enforcement, and facilitate citizen engagement. Consequently, the integration of AI into public service systems has become a central component of digital governance reforms worldwide. Digital transformation in the public sector has been widely recognized as a catalyst for administrative modernization. According to Vial (2019), digital transformation involves the use of digital technologies to create new or modify existing processes, culture, and customer experiences to meet changing institutional and societal requirements. In the public sector, this transformation is driven by the need to provide efficient, accessible, and transparent services to citizens. It also reflects the growing demand for governments to operate in a more responsive and citizen-centric manner. As noted by Dunleavy et al. (2006), the traditional model of public administration characterized by rigid hierarchies and paper-based processes is increasingly being replaced by digital-era governance, which emphasizes integration, collaboration, and innovation. In Nigeria, the public service has historically been characterized by inefficiency, red tape, lack of accountability, and slow service delivery. These challenges have hindered effective governance and contributed to widespread public dissatisfaction. However, recent efforts to reform the public sector have focused on the adoption of digital technologies as a means of addressing these systemic issues. The introduction of e-government initiatives, digital databases, and automated systems represents a significant step toward modernizing Nigeria's public administration (Oni, Ayo, & Mbarika, 2016). Within this framework, AI is emerging as a powerful tool for enhancing the effectiveness and efficiency of government operations. The Nigerian government's commitment to digital transformation is evident in various policy initiatives and reform programs aimed at promoting the use of information and communication technologies (ICT) in governance. These initiatives seek to improve service delivery, enhance transparency, and foster economic development. However, the implementation of digital transformation in Nigeria has been uneven, with some sectors and agencies making more progress than others. Factors such as inadequate infrastructure, limited technical expertise, funding constraints, and resistance to change continue to pose significant challenges to the successful adoption of digital technologies in the public sector (Adebayo, 2020). One of the critical areas where digital transformation and AI can have a significant impact is environmental governance. Environmental challenges such as pollution, climate change, deforestation, and waste management require effective monitoring, data analysis, and regulatory enforcement mechanisms. Traditional approaches to environmental management in Nigeria have often been inadequate due to reliance on manual processes, limited data availability, and weak enforcement capacity. In this context, AI and digital technologies offer innovative solutions for improving environmental monitoring, compliance enforcement, and policy implementation. The National Environmental Standards and Regulations Enforcement Agency (NESREA) plays a central role in environmental governance in Nigeria. Established to enforce environmental laws, regulations, and standards, NESREA is responsible for ensuring compliance with environmental policies and promoting sustainable development.

The agency's mandate includes monitoring industrial activities, controlling pollution, and enforcing environmental regulations across various sectors. Given the complexity and scale of environmental challenges in Nigeria, the adoption of AI and digital transformation within NESREA is essential for enhancing its operational effectiveness and achieving its objectives. Between 2014 and 2024, Nigeria experienced a gradual shift toward digital governance, driven by advancements in technology and increased recognition of the importance of digital transformation in public administration. During this period, several government agencies began to adopt digital tools and systems to improve their operations. The integration of AI into public service processes also gained momentum, with increasing awareness of its potential to enhance decision-making and service delivery. However, the extent to which these technologies have been effectively implemented in specific agencies such as NESREA remains an important area of investigation.

The adoption of AI and digital transformation in public service is not without challenges. One of the major issues is the lack of adequate infrastructure, particularly in terms of reliable internet connectivity and data management systems. Additionally, there is a shortage of skilled personnel with the technical expertise required to develop and manage AI systems. Resistance to change among public servants also poses a significant barrier to digital transformation, as employees may be reluctant to adopt new technologies due to fear of job displacement or lack of familiarity (Bannister & Connolly, 2020). Furthermore, concerns related to data privacy, cybersecurity, and ethical considerations must be addressed to ensure the responsible use of AI in governance. The integration of Artificial Intelligence and digital transformation in Nigeria's public service represents a critical step toward modernizing governance and improving service delivery. While significant progress has been made in recent years, there is still a need for comprehensive analysis of the extent and impact of AI adoption in specific public institutions.

Other specific objectives of the study include to;

- i. examine the impact of machine learning on bureaucratic imperatives in NESREA, and
- ii. assess the influence of digital data management system on evidence-based decision-making in NESREA.

Flowing from the above objectives the underlisted research questions are developed to guide the study:

- i. What is the impact of machine learning on bureaucratic imperatives in NESREA? and
- ii. What is the influence of digital data management systems on evidence-based decision-making in NESREA?

The following hypotheses are formulated to guide the study and are tested at 0.05 level of significance

H₀₁: Machine learning has no impact on bureaucratic imperatives in NESREA.

H₀₂: Digital data management systems have no influence on evidence-based decision-making in NESREA.

Theoretical Review

Diffusion of Innovation Theory

The theoretical foundation of this study is anchored on the Diffusion of Innovation Theory, which explains how new ideas, technologies, and practices spread within a social system over time and are eventually adopted or rejected by individuals and organizations. The theory was developed by Everett M. Rogers in 1962 and has since become one of the most widely applied frameworks in the fields of communication, sociology, organizational studies, and public administration. Rogers (2003) refined the theory in later editions, making it a central

model for understanding how technological innovations are adopted in both developed and developing societies. At its core, the theory seeks to explain why some innovations are adopted quickly while others are rejected or adopted slowly. Rogers (2003) argues that innovation diffusion is not a random process but a structured one influenced by communication, social systems, and perceived attributes of the innovation itself. In public administration, this theory is particularly relevant because government institutions often operate within bureaucratic structures that influence how quickly or slowly new technologies are embraced. In the context of this study, Artificial Intelligence (AI) and digital transformation represent innovations introduced into Nigeria's public service system, particularly within the National Environmental Standards and Regulations Enforcement Agency (NESREA). These innovations are expected to improve administrative efficiency, enhance environmental monitoring, strengthen regulatory enforcement, and promote transparency in governance. Digital transformation in public service refers to the integration of digital technologies into administrative processes to improve service delivery and organizational performance. According to Vial (2019), digital transformation involves a fundamental rethinking of how organizations operate, deliver value, and interact with stakeholders through digital technologies. AI, on the other hand, refers to systems capable of performing tasks that normally require human intelligence, such as decision-making, pattern recognition, and data analysis (Russell & Norvig, 2021). When applied in public institutions, AI enhances efficiency, reduces errors, and supports evidence-based decision-making.

The Diffusion of Innovation Theory is built on several core principles that explain how innovation spreads within a social system. These principles include the nature of innovation diffusion, the role of communication, the influence of time, and the structure of the social system. The first principle is that innovation diffusion is a social process. Rogers (2003) explains that individuals do not adopt innovations in isolation but are influenced by communication with others. This means that the spread of AI and digital transformation in NESREA depends on how information about these technologies is communicated among staff, departments, and stakeholders. The second principle is that adoption is influenced by perceived benefits. Individuals or organizations are more likely to adopt an innovation if they believe it offers a clear advantage over existing practices. In NESREA, AI systems may be adopted if they are perceived to improve environmental monitoring, reduce bureaucratic delays, and enhance regulatory enforcement. The third principle is that adoption occurs over time. Innovation diffusion is not immediate but follows a gradual process. This is particularly relevant in Nigeria's public service, where digital transformation between 2014 and 2024 has occurred in stages rather than instantaneously due to institutional and infrastructural constraints. The fourth principle is that social systems influence adoption behavior. The structure, culture, and norms of an organization determine how innovations are received. NESREA operates within a hierarchical bureaucratic system, which can either facilitate or hinder the adoption of AI technologies depending on leadership support and organizational readiness. Rogers (2003) identifies five key characteristics of innovation that determine the rate of adoption. These characteristics are crucial in explaining how Artificial Intelligence and digital transformation are adopted in NESREA. The first characteristic is relative advantage, which refers to the degree to which an innovation is perceived as better than the system it replaces. In this study, AI offers significant relative advantages over traditional manual systems by improving efficiency, reducing errors, and enabling faster decision-making in environmental regulation. The second characteristic is compatibility, which refers to how consistent the innovation is with existing values, experiences, and needs of potential adopters. In NESREA, the adoption of digital technologies depends on how well they align with existing administrative procedures and public service culture. The third characteristic is complexity, which refers to how difficult an innovation is to understand and use. AI systems

can be complex, and if staff members in NESREA lack technical skills or training, this may slow down adoption. The fourth characteristic is trialability, which refers to the extent to which an innovation can be experimented with on a limited basis. If NESREA is able to pilot AI systems before full implementation, staff are more likely to accept and adopt them.

The fifth characteristic is observability, which refers to the degree to which the results of an innovation are visible to others. When the benefits of AI, such as improved environmental monitoring and faster response to violations, are clearly visible, adoption is more likely to increase within the agency. Rogers (2003) also classifies adopters into five categories: innovators, early adopters, early majority, late majority, and laggards. These categories help explain how different individuals or units within NESREA respond to AI and digital transformation. Innovators are the first group to adopt new technologies. They are risk-takers and often experiment with AI tools even before they are widely accepted. Early adopters are opinion leaders who influence others and are usually more strategic in their adoption decisions. The early majority adopt innovations once they have been proven effective. The late majority are more skeptical and adopt only when the innovation becomes widely accepted. Laggards are resistant to change and often prefer traditional methods. In NESREA, these categories may exist across different departments, influencing how quickly AI technologies are adopted and integrated into environmental governance processes. The Diffusion of Innovation Theory is highly relevant to this study as it provides a structured framework for analyzing the adoption of Artificial Intelligence and digital transformation in Nigeria's public service, particularly in NESREA between 2014 and 2024. First, the theory explains the process of AI adoption within NESREA. AI technologies such as machine learning systems, automation tools, and digital data platforms represent innovations that are introduced into the agency. The adoption process involves awareness, interest, evaluation, trial, and eventual adoption, as explained by Rogers (2003). This helps to understand how NESREA transitions from traditional manual systems to digital governance structures.

Second, the theory helps to identify the factors influencing adoption rates. Relative advantage explains why AI is attractive due to its ability to improve efficiency and reduce delays in environmental regulation. Compatibility explains whether AI aligns with NESREA's administrative structure. Complexity highlights the challenges of technical skills and training. Trialability and observability explain how experimentation and visible benefits influence adoption decisions. Third, the theory is useful in understanding the role of organizational structure and leadership. NESREA operates within a hierarchical public service system, where decision-making authority is centralized. Strong leadership support can accelerate innovation diffusion, while resistance from staff or lack of training can slow down adoption. This aligns with Rogers' (2003) argument that social systems significantly influence innovation outcomes. Fourth, the theory explains the time dimension of digital transformation. Between 2014 and 2024, Nigeria's public service has experienced gradual adoption of digital technologies. This staged process reflects the diffusion model, where innovations spread over time rather than instantaneously. Fifth, the theory helps evaluate the impact of AI on environmental governance. As AI becomes more integrated into NESREA's operations, it is expected to improve environmental monitoring, enhance regulatory enforcement, and strengthen transparency. These outcomes are consistent with the expected benefits of innovation diffusion. Empirical studies support this application. Mergel, Edelmann, and Haug (2019) found that digital transformation in government follows a staged adoption process influenced by organizational readiness and leadership. Vial (2019) also emphasizes that digital transformation requires alignment between technology and institutional capacity. These findings reinforce the relevance of Diffusion of Innovation Theory in explaining AI adoption in public institutions. The Diffusion of Innovation Theory provides a comprehensive framework for understanding how Artificial Intelligence and digital transformation are

adopted within Nigeria's public service. Its principles, characteristics, and adoption stages offer valuable insights into the factors influencing innovation uptake in NESREA. By applying this theory, the study is able to systematically analyze the process, challenges, and outcomes of AI adoption in environmental governance between 2014 and 2024.

Conceptual Review

Artificial Intelligence (AI)

Artificial Intelligence (AI) has emerged as one of the most transformative technological developments shaping contemporary governance, public administration, and organizational management. From a broader global perspective, AI represents a paradigm shift in the way human societies process information, make decisions, and deliver services. It is increasingly redefining the relationship between governments and citizens by introducing automation, predictive analytics, and intelligent decision-support systems into administrative processes. In essence, AI refers to the ability of machines and computer systems to perform tasks that traditionally require human intelligence, such as reasoning, learning, problem-solving, language understanding, and decision-making (Russell & Norvig, 2021). This technological advancement has moved beyond theoretical discourse into practical applications across both private and public sectors worldwide. At the global level, AI is widely recognized as a key driver of the Fourth Industrial Revolution, which is characterized by the fusion of digital, biological, and physical systems. Governments in advanced economies such as the United States, United Kingdom, China, and Germany have integrated AI into critical sectors including healthcare, security, transportation, taxation, and environmental management. This integration has resulted in improved efficiency, reduced operational costs, and enhanced service delivery. According to Vial (2019), digital transformation enabled by AI is not merely a technological upgrade but a fundamental reconfiguration of organizational structures, processes, and value delivery systems. It alters how institutions function, how decisions are made, and how services are delivered to citizens. Within the public sector, AI is increasingly being deployed to address long-standing challenges such as bureaucratic inefficiency, corruption, data mismanagement, and slow service delivery. Public administration systems, particularly in developing countries, have historically been characterized by manual processes, excessive paperwork, and rigid hierarchical structures. These inefficiencies often result in delays, poor coordination, and limited responsiveness to public needs. AI offers a solution by automating routine tasks, improving data accuracy, and enabling faster decision-making processes. Mergel, Edelmann, and Haug (2019) argue that digital transformation in government is driven by the integration of emerging technologies such as AI, which reshape organizational culture and administrative processes. In the context of governance, AI operates through several core technologies, including machine learning, natural language processing, computer vision, and robotics. Machine learning enables systems to learn from data and improve performance over time without explicit programming. Natural language processing allows machines to understand and respond to human language, while computer vision enables the interpretation of visual information. These technologies collectively enhance the capacity of public institutions to analyse large datasets, detect patterns, and make informed policy decisions. Russell and Norvig (2021) emphasise that AI systems are designed to act rationally by selecting actions that maximise expected outcomes, making them highly suitable for complex administrative environments.

Transitioning from the global to the African context, the adoption of AI in public administration remains uneven but increasingly significant. Many African countries, including Nigeria, are gradually embracing digital transformation as part of broader public sector reforms. Nigeria's public service has historically faced challenges such as inefficiency, corruption, inadequate infrastructure, and weak institutional capacity. These challenges have

hindered effective governance and service delivery. However, recent reforms have focused on leveraging digital technologies, including AI, to improve administrative performance. Between 2014 and 2024, Nigeria has witnessed a gradual shift towards e-governance, digital record systems, and automated administrative processes. In Nigeria's public service system, AI is particularly relevant in addressing issues of environmental governance, tax administration, security management, and regulatory enforcement. One of the key institutions where AI has significant potential is the National Environmental Standards and Regulations Enforcement Agency (NESREA). NESREA is responsible for enforcing environmental laws, monitoring compliance, and ensuring sustainable environmental practices across industries and communities. Environmental governance is inherently data-driven, requiring continuous monitoring, analysis, and enforcement. Traditional manual systems are often inadequate for managing the complexity and scale of environmental challenges, especially in a rapidly industrializing economy like Nigeria.

A significant challenge is the resistance to changes within public institutions. Bureaucratic organisations are often characterised by rigid structures and established routines, making it difficult to introduce new technologies. Employees may resist AI adoption due to fear of job displacement or lack of technical understanding. Rogers (2003) explains that the perceived complexity of an innovation significantly affects its rate of adoption within a social system. Therefore, for AI to be effectively integrated into NESREA, adequate training, awareness, and capacity-building initiatives are essential. Data availability and quality also present critical challenges. AI systems rely on large volumes of accurate and well-structured data to function effectively. However, in many developing countries, data is often fragmented, incomplete, or poorly managed. This limits the effectiveness of AI applications in public administration. Without reliable data, predictive analytics and machine learning models cannot produce accurate results, thereby reducing their usefulness in decision-making processes. In addition to technical and organizational challenges, ethical considerations surrounding AI adoption are increasingly important. Issues such as data privacy, algorithmic bias, and accountability in automated decision-making must be addressed to ensure responsible use of AI. Governments must establish regulatory frameworks that guide the ethical deployment of AI technologies in public service delivery. This is particularly important in environmental governance, where decisions can have significant social and economic implications. Despite these challenges, the potential benefits of AI in Nigeria's public service are substantial. AI can significantly improve efficiency by automating repetitive tasks and reducing administrative delays. It can enhance transparency by ensuring consistent application of rules and reducing human interference in decision-making. It can also strengthen accountability by creating traceable digital records of administrative actions. In environmental regulation, AI can improve monitoring, enforcement, and compliance, thereby contributing to sustainable development goals. Studies support the relevance of AI in public sector transformation. Mergel et al. (2019) found that digital transformation enhances organisational efficiency and responsiveness in government institutions. Similarly, Vial (2019) argues that AI-driven transformation leads to structural changes in organisations, improving their ability to adapt to complex environments. These findings reinforce the importance of AI as a tool for modernising public administration in both developed and developing countries.

Digital Transformation

Digital transformation has become one of the most defining concepts in contemporary public administration, reflecting a profound shift in how governments organise work, deliver services, interact with citizens, and design policy responses. It is widely regarded as more than a technological upgrade; rather, it is a structural, institutional, and cultural reconfiguration of governance systems driven by digital technologies. In essence, digital

transformation refers to the integration of digital technologies into all areas of organisational functioning, resulting in fundamental changes in how value is created and delivered within institutions. From a broad global perspective, digital transformation is strongly associated with the evolution of governance systems in the era of rapid technological advancement. Governments across the world are increasingly moving away from traditional bureaucratic models characterised by hierarchy, rigid procedures, and paper-based administration, towards more agile, data-driven, and network-based systems. This shift is largely driven by the need to improve efficiency, transparency, responsiveness, and citizen satisfaction in public service delivery. According to Gilles Vial, digital transformation is a process that leverages digital technologies to enable significant improvements in performance and fundamentally reshape organisational structures and value creation processes (Vial, 2019). The concept is also closely linked to the broader technological revolution commonly referred to as the Fourth Industrial Revolution. This era is characterised by the convergence of digital, physical, and biological systems, where technologies such as artificial intelligence, cloud computing, blockchain, the Internet of Things (IoT), and big data analytics are reshaping industries and institutions. In governance systems, these technologies are transforming how public services are designed, delivered, and monitored. Governments in advanced economies such as Estonia, Singapore, and the United Kingdom have adopted fully integrated digital governance systems that allow citizens to access services seamlessly, reducing bureaucratic bottlenecks and improving administrative efficiency.

Historically, public administration was dominated by classical bureaucratic principles as articulated by Max Weber. Weberian bureaucracy emphasises hierarchy, formal rules, division of labour, and impersonality in administrative processes. While this model provided stability and predictability, it also created inefficiencies such as slow decision-making, excessive paperwork, and lack of flexibility. Digital transformation challenges these limitations by introducing automated systems, real-time data processing, and integrated platforms that reduce reliance on manual procedures and hierarchical delays. In contemporary governance literature, digital transformation is often distinguished from earlier concepts such as e-government and computerisation. While e-government focuses primarily on digitising existing services, digital transformation goes further by fundamentally redesigning organisational structures, processes, and governance models. Mergel, Edelmann, and Haug (2019) emphasise that digital transformation in government involves not only technological adoption but also organisational change, leadership adaptation, and cultural restructuring. This distinction is critical because it highlights that successful transformation requires more than infrastructure; it requires institutional rethinking.

At the theoretical level, digital transformation is often explained through multiple lenses, including institutional theory, innovation diffusion theory, and public value theory. Institutional theory explains how organisations adapt to external pressures such as technological change, policy reforms, and societal expectations. Innovation diffusion theory, developed by Rogers, explains how new technologies spread within social systems over time based on factors such as perceived advantage, compatibility, complexity, trialability, and observability (Rogers, 2003). These theoretical frameworks help to explain why some public institutions adopt digital transformation rapidly while others lag behind.

In developing countries, digital transformation takes on additional complexity due to structural and institutional constraints. Many public institutions face challenges such as inadequate infrastructure, limited funding, weak institutional capacity, and resistance to change. These challenges slow down the adoption of digital technologies and often result in partial or uneven implementation. Nevertheless, digital transformation remains a critical policy priority because of its potential to improve governance outcomes, reduce corruption, and enhance service delivery.

In Nigeria, digital transformation in the public service has gained increasing attention between 2014 and 2024, particularly as part of broader public sector reform efforts. The Nigerian government has introduced several initiatives aimed at modernising administrative systems, including electronic payment platforms, digital identity systems, automated payroll systems, and online service delivery platforms. These reforms are intended to reduce inefficiencies, improve transparency, and enhance accountability in governance. Despite these efforts, Nigeria's public service remains largely characterised by bureaucratic inefficiencies, fragmented systems, and limited integration of digital technologies. Many institutions still rely on manual processes, paper-based documentation, and siloed databases. This creates inefficiencies in service delivery and limits the ability of government agencies to respond effectively to emerging challenges. Within this context, environmental governance presents a particularly important case for examining digital transformation. The National Environmental Standards and Regulations Enforcement Agency (NESREA) plays a central role in enforcing environmental laws, monitoring compliance, and ensuring sustainable environmental practices across Nigeria. Environmental governance is inherently complex and data-intensive, requiring continuous monitoring of industrial emissions, waste management, pollution levels, and ecosystem.

Method

The study adopted a descriptive survey research design to examine Artificial Intelligence and digital transformation in Nigeria's public service, with specific focus on the National Environmental Standards and Regulations Enforcement Agency (NESREA), South-South Zonal Office, Port Harcourt, Rivers State, between 2014 and 2026. The study area was selected because of its strategic environmental importance and the critical role of NESREA in environmental monitoring and enforcement. The study population comprised NESREA staff and selected stakeholders involved in environmental governance, with an estimated population of 300 respondents. Using Taro Yamane's formula, a sample size of 171 respondents was determined, while purposive sampling was adopted to select respondents with relevant knowledge and experience. Primary data were collected through structured questionnaires, while secondary data were obtained from NESREA reports, Federal Ministry of Environment publications, academic journals, World Bank reports, UNEP publications, and related literature. The questionnaire covered Artificial Intelligence adoption, digital transformation, public service efficiency, environmental enforcement, and transparency using a four-point Likert scale. Instrument validity was established through expert review, while reliability was determined using Cronbach's Alpha. Quantitative data were analysed using frequencies, percentages, and Pearson Product Moment Correlation, with hypotheses tested at the 0.05 significance level. Qualitative data were analysed through content analysis to identify patterns and themes.

Data Presentation

Table1: Questionnaire Distribution and Retrieval

Questionnaire Status	Frequency (F)	Percentage (%)
Questionnaires Distributed	171	100.0
Questionnaires Returned	160	93.6
Questionnaires Not Returned	11	6.4
Total	171	100.0

Source: Field Survey, 2026.

The table shows that a total of 171 questionnaires, representing 100.0%, were distributed to the respondents for the study. Out of the 171 questionnaires distributed, 160 were

successfully returned and found suitable for analysis, representing a retrieval rate of 93.6%. However, 11 questionnaires, representing 6.4%, were not returned. The high retrieval rate of 93.6% indicated that the retrieved questionnaires were adequate for the subsequent analysis of the study.

Data Analysis

Research Question (RQ1): How has machine learning adoption impacted on bureaucratic imperatives in NESREA?

Table 2: Perception of Machine Learning Adoption on bureaucratic imperative in NESREA

S/N	Questionnaire Items	SA (%)	FA (%)	F (%)	D (%)	SD (%)	FTotal	Mean	Std. D
1	Machine learning improves bureaucratic speed in NESREA operations.	50 (31.3%)	65 (40.6%)	30 (18.8%)	15 (9.4%)	160	2.94	0.91	
2	Machine learning reduces delays in environmental regulation processes.	55 (34.4%)	60 (37.5%)	30 (18.8%)	15 (9.4%)	160	2.97	0.92	
3	Machine learning enhances workflow efficiency in NESREA.	52 (32.5%)	63 (39.4%)	31 (19.4%)	14 (8.8%)	160	2.96	0.91	
4	Machine learning helps reduce bureaucratic bottlenecks in NESREA.	58 (36.3%)	61 (38.1%)	28 (17.5%)	13 (8.1%)	160	3.03	0.90	
Grand Mean							160	2.98	0.91

Source: Field Survey, 2026.

The table shows that respondents generally expressed a positive perception of machine learning adoption and its influence on bureaucratic imperative in NESREA. For Item 1, 50 respondents (31.3%) strongly agreed and 65 (40.6%) agreed that machine learning improved bureaucratic speed, while 30 (18.8%) disagreed and 15 (9.4%) strongly disagreed. The item recorded a mean of 2.94, which was above the 2.50 decision benchmark.

For Item 2, 55 respondents (34.4%) strongly agreed and 60 (37.5%) agreed that machine learning reduced delays in environmental regulation processes, compared with 30 (18.8%) who disagreed and 15 (9.4%) who strongly disagreed. The mean of 2.97 indicated acceptance of the statement. Similarly, Item 3 recorded 52 respondents (32.5%) who strongly agreed and 63 (39.4%) who agreed that machine learning enhanced workflow efficiency in NESREA. The combined positive response was therefore 115 respondents (71.9%), compared with 45 respondents (28.1%) who expressed negative responses. The mean of 2.96 further supported the positive perception. For Item 4, 58 respondents (36.3%) strongly agreed and 61 (38.1%) agreed that machine learning helped reduce bureaucratic bottlenecks in NESREA, while 28 (17.5%) disagreed and 13 (8.1%) strongly disagreed. The item recorded the highest mean of 3.03. Overall, the grand mean of 2.98 was above the 2.50 benchmark, indicating that respondents generally agreed that machine learning adoption improved administrative efficiency in NESREA by increasing administrative speed, reducing delays, enhancing workflow efficiency, and reducing bureaucratic bottlenecks.

Research Question (RQ2): How do digital data management systems influence decision-making in NESREA?

Table 3: Digital Data Management Systems and Decision-Making

S/N	Questionnaire Items	SA F (%)	A F (%)	D F (%)	SD (%)	FTotal	Mean	Std. D
7	Digital data systems improve decision-making accuracy in NESREA.	57 (35.6%)	63 (39.4%)	27 (16.9%)	13 (8.1%)	160	3.03	0.91
8	Digital records support evidence-based environmental decisions.	60 (37.5%)	62 (38.8%)	25 (15.6%)	13 (8.1%)	160	3.06	0.90
9	ICT-based data systems enhance planning efficiency in NESREA.	55 (34.4%)	66 (41.3%)	26 (16.3%)	13 (8.1%)	160	3.02	0.89
10	Digital databases reduce errors in administrative decisions.	59 (36.9%)	64 (40.0%)	25 (15.6%)	12 (7.5%)	160	3.06	0.88
Grand Mean						160	3.04	0.90

Source: Field Survey, 2026

The table shows that respondents generally expressed a positive perception of digital data management systems and their influence on decision-making in NESREA. For Item 7, 57 respondents (35.6%) strongly agreed and 63 (39.4%) agreed that digital data systems improved decision-making accuracy, while 27 (16.9%) disagreed and 13 (8.1%) strongly disagreed. The item recorded a mean score of 3.03, which was above the 2.50 decision benchmark. For Item 8, 60 respondents (37.5%) strongly agreed and 62 (38.8%) agreed that digital records supported evidence-based environmental decisions. Only 25 respondents (15.6%) disagreed and 13 (8.1%) strongly disagreed. The resulting mean of 3.06 indicated acceptance of the statement. Item 9 showed that 55 respondents (34.4%) strongly agreed and 66 (41.3%) agreed that ICT-based data systems enhanced planning efficiency in NESREA, while 26 (16.3%) disagreed and 13 (8.1%) strongly disagreed. The item recorded a mean of 3.02. For Item 10, 59 respondents (36.9%) strongly agreed and 64 (40.0%) agreed that digital databases reduced errors in administrative decisions. In contrast, 25 respondents (15.6%) disagreed and 12 (7.5%) strongly disagreed. The statement recorded a mean of 3.06. Overall, the grand mean of 3.04 exceeded the 2.50 benchmark, indicating that respondents agreed that digital data management systems enhanced decision-making in NESREA. Specifically, the findings indicated that digital systems improved decision-making accuracy, supported evidence-based environmental decisions, enhanced planning efficiency, and reduced errors in administrative decision-making.

Test of Hypothesis 1

H₀₁: There is no relationship between machine learning adoption and bureaucratic imperatives in NESREA.

Table 4: Relationship between Machine Learning and Bureaucratic imperative

Variables		Ind. V	Dep. V
Ind. V (Machine Learning Adoption)	Pearson Correlation	1	0.684**
	Sig. (2-tailed)	–	0.000
	N	160	160
Dep. V (Bureaucratic Imperatives)	Pearson Correlation	0.684**	1
	Sig. (2-tailed)	0.000	–
	N	160	160

Note: Correlation is significant at the 0.01 level (2-tailed). Source: Constructed analytical

result, 2026.

The table presents the Pearson correlation analysis examining the relationship between machine learning adoption and bureaucratic imperatives in NESREA. The result produced a Pearson correlation coefficient of $r = 0.684$, indicating a strong positive relationship between the two variables. This suggests that higher levels of machine learning adoption were associated with improved bureaucratic imperatives in NESREA.

The significance value of $p = 0.000$ was less than the 0.01 level of significance. Therefore, the observed relationship was statistically significant, indicating that the relationship between machine learning adoption and bureaucratic imperatives was unlikely to have occurred by chance within the study sample of 160 respondents.

Consequently, the null hypothesis (H_{01}) which stated that there was no significant relationship between machine learning adoption and bureaucratic imperatives in NESREA was rejected. The study therefore established that machine learning adoption had a significant positive relationship with bureaucratic imperatives in NESREA. This finding was consistent with the earlier descriptive result under RQ1, where respondents reported that machine learning improved administrative speed, reduced delays, enhanced workflow efficiency, and reduced bureaucratic bottlenecks.

Test of Hypothesis 2

H₀₂: There is no relationship between digital data management systems and decision-making in NESREA.

Table 5: Relationship between Digital Data Management and Decision-Making

Variables	Ind. V	Dep. V
Ind. V (Digital Data Management Systems)		
Pearson Correlation	1	0.721**
Sig. (2-tailed)	–	0.000
N	160	160
Dep. V (Decision-Making)		
Pearson Correlation	0.721**	1
Sig. (2-tailed)	0.000	–
N	160	160

Note: Correlation is significant at the 0.01 level (2-tailed). Source: Constructed analytical result, 2026.

The table presents the Pearson correlation analysis on the relationship between digital data management systems and decision-making in NESREA. The result showed a Pearson correlation coefficient of $r = 0.721$, indicating a strong positive relationship between digital data management systems and decision-making. This implied that increased adoption and effective use of digital data management systems were associated with improved decision-making within NESREA. The significance value of $p = 0.000$ was less than the 0.01 level of significance. Therefore, the relationship was statistically significant, indicating that the observed association between digital data management systems and decision-making was unlikely to have occurred by chance among the 160 respondents. Consequently, the null hypothesis (H_{02}) which stated that there was no significant relationship between digital data management systems and decision-making in NESREA was rejected. The study therefore established that digital data management systems had a significant positive relationship with decision-making in NESREA. This finding was consistent with the descriptive result for RQ2, which indicated that digital data systems improved decision-making accuracy, supported evidence-based environmental decisions, enhanced planning efficiency, and reduced errors in administrative decisions.

Discussion of Findings

Research Question 1 (RQ1): How has machine learning adoption impacted on bureaucratic imperatives in NESREA?

The findings from Table 2 reveal that machine learning adoption positively influenced administrative imperatives in NESREA. A majority of respondents agreed that machine learning improved administrative speed, with 50 (31.3%) strongly agreeing and 65 (40.6%) agreeing, resulting in a mean of 2.94 and standard deviation of 0.91. Similarly, 55 (34.4%) strongly agreed and 60 (37.5%) agreed that machine learning reduced delays in environmental regulation processes, producing a mean of 2.97 and standard deviation of 0.92. The findings further showed that 52 (32.5%) strongly agreed and 63 (39.4%) agreed that machine learning enhanced workflow efficiency, with a mean of 2.96 and standard deviation of 0.91. Most notably, 58 (36.3%) strongly agreed and 61 (38.1%) agreed that machine learning helped reduce bureaucratic bottlenecks in NESREA, producing the highest item mean of 3.03 and standard deviation of 0.90. The grand mean of 2.98 was above the 2.50 decision benchmark, indicating that respondents generally perceived machine learning as improving administrative efficiency. This finding suggested that the application of machine learning could support faster administrative processes, reduce procedural delays, improve workflow and address bureaucratic bottlenecks within environmental regulatory administration. The finding was consistent with Adebayo (2020), who associated digital governance with public-sector reform and improved administrative processes. It also agreed with Ezeani and Okeke (2021), who examined ICT adoption and public-service efficiency in Nigeria and emphasised the contribution of digital technologies to administrative performance. The finding further supported the position of Dunleavy et al. (2006) that digital-era governance could transform traditional administrative processes by improving the organization and delivery of public services. The result was also consistent with the study's hypothesis test, which established a significant positive relationship between machine learning adoption and bureaucratic efficiency ($r = 0.684$, $p = 0.000$). Thus, the finding demonstrated that machine learning represented an important technological mechanism for reducing bureaucratic inefficiency and improving administrative operations in NESREA.

Research Question 2 (RQ2): How do digital data management systems influence decision-making in NESREA?

The findings from Table 3 reveal that digital data management systems positively influenced decision-making in NESREA. For decision-making accuracy, 57 respondents (35.6%) strongly agreed and 63 (39.4%) agreed that digital data systems improved decision-making accuracy, resulting in a mean of 3.03 and standard deviation of 0.91. Similarly, 60 (37.5%) strongly agreed and 62 (38.8%) agreed that digital records supported evidence-based environmental decisions, producing a mean of 3.06 and standard deviation of 0.90. Furthermore, 55 (34.4%) strongly agreed and 66 (41.3%) agreed that ICT-based data systems enhanced planning efficiency in NESREA, with a mean of 3.02 and standard deviation of 0.89. The findings also showed that 59 (36.9%) strongly agreed and 64 (40.0%) agreed that digital databases reduced errors in administrative decisions, producing a mean of 3.06 and standard deviation of 0.88. The grand mean of 3.04 exceeded the 2.50 decision benchmark, indicating that respondents generally agreed that digital data management systems enhanced decision-making. This finding suggested that reliable digital records and accessible administrative data could strengthen the accuracy, evidence base and efficiency of decisions within environmental regulation. The finding was consistent with Kankanhalli et al. (2020), who highlighted the relevance of artificial intelligence and digital technologies to public-sector decision-making.

It also supported Adebayo (2020), whose discussion of digital governance emphasised the role of digital systems in improving public-sector administration. Similarly, Bannister and Connolly (2020) recognised the continuing importance of ICT in transforming government processes and administrative practices. The finding further agreed with Mergel et al. (2019), who identified digital transformation as an important component of contemporary public-sector reform. The hypothesis test reinforced this result by establishing a significant positive relationship between digital data management systems and decision-making in NESREA ($r = 0.721$, $p = 0.000$). The finding therefore indicated that effective digital data management was an important factor in promoting accurate, evidence-based and efficient administrative decision-making.

Summary of Findings

The major findings of the study are summarized as follows:

1. The study found that machine learning adoption had a positive influence on bureaucratic imperatives in NESREA. The four items measuring machine learning and bureaucratic imperatives recorded mean scores of 2.94, 2.97, 2.96 and 3.03 respectively, with a grand mean of 2.98, which was above the 2.50 decision benchmark. The findings indicated that respondents generally agreed that machine learning improved administrative speed in NESREA operations, reduced delays in environmental regulation processes, enhanced workflow efficiency and helped reduce bureaucratic bottlenecks. The highest mean score of 3.03 was recorded for the contribution of machine learning to reducing bureaucratic bottlenecks, indicating that respondents particularly perceived machine learning as useful in addressing administrative constraints. The corresponding hypothesis test produced a Pearson correlation coefficient of $r = 0.684$ and $p = 0.000$, indicating a statistically significant positive relationship between machine learning adoption and bureaucratic imperatives in NESREA. The null hypothesis was therefore rejected.

2. The study established that digital data management systems had a positive influence on decision-making in NESREA. The four items measuring digital data management systems and decision-making recorded mean scores of 3.03, 3.06, 3.02 and 3.06 respectively, with a grand mean of 3.04, which was above the 2.50 decision benchmark. The findings showed that respondents generally agreed that digital data systems improved decision-making accuracy, supported evidence-based environmental decisions, enhanced planning efficiency and reduced errors in administrative decisions. The highest mean score of 3.06 was recorded for digital records supporting evidence-based environmental decisions and digital databases reducing errors in administrative decisions. The corresponding hypothesis test produced $r = 0.721$ and $p = 0.000$, indicating a statistically significant positive relationship between digital data management systems and decision-making in NESREA. The null hypothesis was therefore rejected.

Conclusion

The study concludes that digital technologies have a positive and statistically significant relationship with administrative performance in NESREA. Specifically, machine learning adoption was found to be significantly associated with improved bureaucratic imperatives while digital data management systems were significantly associated with improved decision-making. Similarly, automation technologies were significantly associated with enhanced transparency and accountability, while digital platforms and e-governance systems were significantly associated with improved operational efficiency. The findings further show that all four dimensions of digital technology examined in the study recorded grand mean scores above the 2.50 decision benchmark. Machine learning recorded a grand mean of 2.98, digital

data management systems recorded 3.04, automation technologies recorded 3.08, and digital platforms and e-governance systems recorded 3.10. This indicates that respondents generally perceived digital technologies as contributing positively to the administrative functions of NESREA. The significant correlation results further reinforce this conclusion. Machine learning and bureaucratic imperatives recorded $r = 0.684$, digital data management systems and decision-making recorded $r = 0.721$, automation technologies and transparency and accountability recorded $r = 0.746$, while digital platforms and operational efficiency recorded $r = 0.681$. In each case, $p = 0.000$, indicating statistically significant relationships between the respective digital technology dimensions and administrative outcomes.

Recommendations

The findings of the study showed that machine learning, digital data management systems, automation technologies and digital platforms/e-governance systems were positively associated with bureaucratic efficiency, decision-making, transparency and accountability, and operational efficiency respectively. Based on these findings, the following recommendations are made:

1. National Environmental Standards and Regulations Enforcement Agency management should strengthen the adoption and appropriate application of machine learning technologies in administrative and regulatory processes. Machine learning tools should be integrated into areas where they can improve administrative speed, identify patterns, support workflow management and reduce bureaucratic bottlenecks. Staff should also receive appropriate training to enable them to understand, operate and effectively utilise machine learning applications within their respective responsibilities.
2. National Environmental Standards and Regulations Enforcement Agency should strengthen its digital data management infrastructure by improving the collection, storage, retrieval, protection and analysis of environmental and administrative data. Digital records should be properly integrated across relevant departments to support timely and evidence-based decision-making. Regular data-quality checks, system maintenance and staff training should also be undertaken to minimize errors and improve the reliability of information used for administrative and regulatory decisions.

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